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Heater Test With Apples - Wenatchee, Washington To Chicago, Illinois - February 1949

By

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Object of Test

The refrigerator car heaters that were tested during the winters of 1946-7 and 1947-8 were of the portable type installed in the bunkers of standard 40 ft. end bunker cars, with and without air circulating fans. These tests demonstrated the value of forced air circulation in obtaining a uniform distribution of heat throughout the load when such heaters are installed in one or both ends of the car. During the past year, the Burlington Refrigerator Express Company has adapted the permanently installed Luminator-Mitchell underslung charcoal heater (extensively used by the Canadian roads) to two types of its cars, an overhead bunker and a regular end bunker fan car. Also, a mechanical refrigeration and heating unit, originally designed and used in refrigerated trucks was installed in a refrigerator car by the Western Fruit Express Company and was available for test at the same time.

Therefore, as both systems appeared to give promise of improved heater service in the movement of apples and pears from the Northwest the car lines requested the Department to cooperate in conducting this test to obtain information on their performance even though it was very late in the season when the equipment became available. In order to compare them with currently available heater and car equipment, four additional cars were used. The test, therefore, included thermostatically controlled alcohol and charcoal heaters and non-controlled charcoal heaters in fan cars and standard charcoal heaters in a non-fan car in addition to those with the underslung charcoal heaters and the one with the mechanical unit.

Summary of Results

Although the severe winter weather continued almost until the time of departure of the test, it was followed by such mild weather in transit that no heaters were lit except the pilots of the Preco heaters and the Luminator-Mitchell heater in car C which was operated under Canadian rules (bottom air temperatures). The Thermo-King units were operated throughout the transit period, shifting from heating to refrigeration as the outside temperature varied. Their operation under these mild conditions was satisfactory with a very close and uniform control of commodity temperatures. While the Preco heaters were on pilot only, there was a gradual rise in average commodity temperatures due to the heat from the pilots. Satisfactory temperatures were obtained in the car equipped with the Luminator-Mitchell heater after it was lit. Operation of the heat exchanger also appeared satisfactory. In general, the fan cars showed a more uniform commodity temperature throughout the test than the two non-fan cars, with a smaller temperature spread between top and bottom fruit.

Equipment Tested

The cars used and the heaters tested are listed below followed by a complete description of each heater and its installation:

Code No.	Car No.	Type Car	Heater	Type Heater
A	WFEX 67564	Standard	Thermo-King	Mechanical
B	FGEX 40,000	Fan	Luminator-Mitchell (sylphon valve)	Charcoal
C	BREX 74699	Overhead bunker	Luminator-Mitchell (sylphon valve)	Charcoal
D	BREX 74698	Fan	Luminator-Mitchell (manual control)	Charcoal
E	FGEX 56292	Fan	Preco	Alcohol
F	FGEX 57676	Fan	Simplex Thermo.	Charcoal
G	FGEX 56297	Fan	Simplex Standard	Charcoal
H	FGEX 57545	Non-fan	Simplex Standard	Charcoal

Thermo-King

The Thermo-King model RY refrigerating and heating system consists of two completely self-contained units installed in one end of a standard car, the compartment containing the units being separated from the loading space by an insulated bulkhead. Each unit is mounted on a file-drawer type of base and may be pulled completely outside the car for quick removal or replacement. Access to the units is achieved by raising a sliding panel operated by a removable crank which simultaneously unlocks the units for withdrawal. Only three simple connections, fuel, battery and controls, must be broken to remove a unit. A built-in flue above each unit carries off the exhaust gases from the engine and the heat from the radiator and condenser.

The compressor is directly driven by a 4 cylinder gasoline engine which is fully automatic in operation. A starter-generator, built as a compound unit directly mounted on the crankshaft replaces the conventional flywheel. The engine develops approximately 16 H.P. at 2500 RPM and has an automatic choke, engine unloading device, and thermostatic control to prevent freezing. The unit features a reverse cycle heating system whereby heating as well as cooling is provided. Controls are so arranged that one or both units automatically provide either heating or refrigeration in accordance with thermostat setting and load condition. One unit only will operate under normal conditions but if the load should increase beyond its capacity the other unit will automatically cut in. Other features of the refrigeration system include automatic defrosting of the evaporator by a clock-type mechanism and humidity control through prevention of excessively low evaporator coil temperatures.

Forced air circulation in the car is provided by means of a fan located at the top of the cooling coil of each unit which forces air out into the loading space by means of a duct extending along the ceiling about 2/3 the length of the car. The end of the duct is open to provide air movement to the far end of the car. Openings along the sides of the duct permit the air to move laterally to the sides and down behind the wall racks to the space under the floor racks from whence it is drawn back into the units through a flue on the bulkhead next to the engine compartment. The thermostat bulb is placed in the path of the return air in this flue. An electrically driven auxiliary fan is installed in the air duct above the regular fans and is controlled to operate when the regular units are shut down. In this way a constant forced air circulation is maintained, thereby providing closer control by the thermostat. The batteries and fuel tank are mounted under the car. Each unit weighs slightly under 1000 pounds with the total weight of the two units, ducts, tanks, fuel and batteries approximately 3500 lbs.

Luminator-Mitchell Underslung Heater

This charcoal heater is permanently located in a position under the floor at the doorway where it is readily accessible from the ground for servicing and control. The heater contains a heating coil in the firebox which is connected to a single pipe coil located under the floor racks and extending around the car about 12" away from the wall. In the fan cars the pipe does not extend beyond the fan housing but crosses to the opposite side about 12 inches from it. As the liquid (Prestone) is heated it circulates through the coil and returns to the heater for re-warming. In cars B (FGE 40,000) and C (BRE 74699), this flow of warm liquid is regulated by a thermostatically controlled valve whose bulb is located under the floor racks adjacent to the liquidometer bottom bulb. The air temperature desired is obtained by appropriate setting of the thermostat. Both of these cars are equipped with a heat exchanger located under the car, for dissipating the heat when the thermostat valve has shut off circulation through the coil in the car, thereby preventing overheating the fluid in the heater. In car D (BRE 74698), manual control is effected by manipulating the draft dampers of the heater in accordance with the air temperatures inside the car as indicated by the Liquidometer. In all heater installations the burning rate is controlled by the adjustable damper which has eight positions. When heat is no longer desired the damper is set at 0, or completely closed.

Preco Thermostatically Controlled Alcohol Heater

This heater, described in detail in previous reports,[1/] is of the wick type with control effected by means of a thermostatically operated snuffer plate which covers the wick. On previous models, the snuffer operated by a snap action from off to full burning. The snuffer of the current production model has a modulating action in that it rises gradually to full-on position or to closed (or pilot).

1/ Comprehensive Report on Heater Tests issued July, 1948 (AAR-USDA Tests 22, 23, 24, 25, 26 and 27)

Simplex Thermostatically Controlled Alcohol Heater

This heater, also previously tested and described,[1/] is a standard one piece charcoal heater with a thermostatically controlled damper which when in the off or closed position, reduces the burning rate to less than one half of the full burning rate. One of the two heaters included in the test was made largely of aluminum which reduced its weight by approximately 20 lbs.

Standard Charcoal Heater

Regular one piece heater currently in regular use.

Test Cars

The types of cars used are listed below together with their general characteristics:

Car No.	Type	Insulation	Ht. Floor racks	Sidewall Flues, or racks	Sheathing
A - [illegible] 6756	Special-Non-fan	4 - 4-1/2"	4-3/4"	1-1/2" Racks	Wood
B - FGE 40,000	Fan	3-1/2 - 4"	7-1/2"	1" Flues	Aluminum
C - BRE 74699	Overhead bunker	3-3-1/2"	6"	1" Flues	Steel
D - BRE 74698	Fan	3 - 3-1/2"	7-1/4"	None	Steel
E - FGE 56292	Fan	3 - 3-1/2"	7-1/2"	None	Wood
F - FGE 57676	Fan	3 - 3-1/2"	6-1/2"	None	Wood
G - FGE 56297	Fan	3 - 3-1/2"	7-1/2"	None	Wood
H - FGE 57545	Non-fan	3 - 3-1/2"	4-1/2"	None	Wood

Car A was newly rebuilt with the Thermo-King units installed during the rebuilding. Both units were installed in the A end in an insulated metal lined compartment. There was no bunker in the B end and no hatch openings. Two ventilator openings were provided instead of regular hatches over the engine compartment. The elimination of the one bunker gave a loading space 33' 11" in length or about 8" more than in the regular 40 foot end bunker car. On the bulkhead next to the engine compartment, the wall rack slats were fastened to 2 x 4's on edge to provide a flue for the return air. This end was covered with sheet metal from the top of the floor racks so that all return air would be drawn from under the floor racks up to the intake openings situated about 5 ft. above the floor. Bottom openings originally provided in the discharge air duct along the ceiling were closed to prevent a direct blast on the top of the load and to increase the air movement laterally to the sides of the load.

In the three cars with the underslung heaters (B, C, and D), the openings between the floor rack slats directly above the pipe coil on the floor were plugged (6" each way from the pipe) to prevent possible overheating of the commodity placed directly over the pipe.

Car B was built in 1947 and has been in regular service since that time. Cars E to H are recent rebuilds that have been in service. Cars C and D were equipped with Liquidometers and Car B with thermal blisters for indicating top and bottom air temperature inside the cars.

1/ Comprehensive Report on Heater Tests issued July, 1948 (AAR-USDA Tests 22, 23, 24, 25, 26 and 27)

Commodity Temperatures

Commodity and air temperatures were read by means of distant reading resistance thermometers placed in the air or in fruit in boxes at the following positions:

Position	Designation
Bottom bunker north side, head and rear	BBNS-H, BBNS-R
Top " center line, " " "	TBCL-H, TBCL-R
Bottom quarter, center line, head	BQCL-H
Top " " " , head and rear	TQCL-H, TQCL-R
Top doorway, center line	TDCL
Bottom doorway, north side, head and rear	BDNS-H, BDNS-R
Top Liquidometer bulb position (Air)	
Bottom " " " (Air)	

Fruit temperatures were taken by inserting a resistance thermometer bulb into an apple in the top or bottom outside layer in a box. Two positions were used at the bottom doorway north side, one over the inlet end of the pipe coil (rear) and one over the outlet end (head) in order to determine the effects of the drop in temperature from one end of the coil to the other in the cars equipped with underslung heaters. In order to make comparisons between average commodity temperatures in all the cars these positions were also used in the cars not so equipped. The thermometers for simulating liquidometer or blister air temperatures were placed adjacent to the liquidometer or blister position. Here again, this position was used in all cars whether so equipped or not. Top air position was 1" below the ceiling, centerline of the car at the doorway and the bottom position was under the floor rack, near the centerline at the doorway. The bottom blister position was simulated by placing the thermometer near the doorpost 1" above the floor rack and 1" from the wall. Special single drops were used to obtain the air temperature in the bunker at the thermostat of each Preco heater in Car E. Commodity and air temperatures were read at terminals and other stops en route.

A Ryan recording thermometer was placed under the floor rack in each of the underslung heater cars and the Thermo-King car. In the latter car others were placed next to the air duct at the ceiling and under the floor rack at the end next to the units and next to the air duct at the ceiling at the doorway. In addition, a Ryan was placed over each Preco heater to record full burner operation.

Test Procedure and Loading

The installation of the units in the Thermo-King car was completed at the WFE shops in St. Paul just prior to the test so the car was moved westward with the business car and the factory engineers in order to make final running tests and adjustments. Upon arrival at Wenatchee, the sheet metal covering over the bulkhead between loading and engine space was installed. This together with repairs necessary to stop a leak in one of the underslung heater cars delayed loading one day.

The cars were loaded at Wenatchee and nearby points on February 24 under mild weather conditions. Complete loading data on each car is found in table 1. Outside temperatures ranged between 20° and 40°F. on the day previous to loading, making preheating of the cars unnecessary. The Thermo-King units were started immediately after loading was completed. All the cars were assembled at Appleyard the day following loading and the portable heaters installed. The pilots of the Preco heaters were lit and the test train departed at 5:50 p.m.

Discussion of Results

Although the winter season was nearly over, its severity gave promise of a good chance for heater service even at the late date when the test was arranged. Original plans called for the test to be started about two weeks earlier but the work on the test cars was not completed when anticipated. The weather en route was unusually mild, averaging near 30°F. see figure 1. For only a few hours was the temperature below 10°, with a minimum of 6° at Minot, N. D. As a result only one heater was lighted. This was on Car C when the bottom air temperature reached 29.5° at Minot. The Preco heaters remained on pilot throughout the transit period. Total elapsed time for the trip to Chicago was 137 hours 55 minutes, of which 70 hours and 30 minutes (51 per cent) was running. (Table 2.)

As previously stated, the Thermo-King units were started immediately after loading. They brought the load to about 34°F. temperature in a few hours. Very uniform temperatures were obtained as may be seen in figure 3. As the thermostats had not been accurately calibrated it was felt that a temperature not lower than 32° or 33° was desirable for this first trip in order to insure against possible freezing of any part of the load. However, as the 34° load temperature was closely maintained overnight to Hillyard the thermostat was lowered 1° from 31° to 30° and kept at that position for the balance of the test. Commodity temperatures were quickly adjusted to this new setting and were maintained very close to 33° thereafter. During the early part of the test the units, when operating, were on the refrigeration cycle and produced a slightly lower average temperature in the top than in the bottom of the load. When the coldest weather was encountered and heat was applied, the average tops were slightly warmer, the maximum spread being 1.6°. Little operating trouble was encountered. Dirt in the fuel lines necessitated removal and cleaning of a fuel pump on one occasion. Another minor adjustment made was to set up the generator charging rate. Engine hour meters installed to record the operation of each unit showed a total of 34 to 36 hours operation. However, both units were not turned on all of the time because of making the adjustments. Under normal operation, one unit is set to operate about 2° behind the other. In this test because the load conditions were so light, only one machine was operating at any given time. Estimated total fuel consumed was 16-3/4 gallons or approximately 1/2 gallon per hour. A summary of performance during the transit period is contained in table 12.

As stated above, the underslung charcoal heater in Car C (overhead bunker) was lighted at Minot when the bottom air temperature at the doorway dropped to 29.5°F. This was in accordance with rules for such heater operation as practiced by the Canadian Railroads. At this time, the average bottom commodity temperatures had dropped about 3° to 32.1° and 14 hours later had risen to 36.8° (Fig. 4). Fruit in the bottom of the load immediately over the heating pipe inlet (BDNS-R) showed a slightly more rapid temperature rise than that placed over the outlet which was to be expected as the liquid had cooled considerably after circulating completely around the floor of the car. As shown in Table 5, this difference was not great at any one time. As the heater installation was experimental, the thermostatic valve installed was only roughly calibrated and will be replaced with a properly engineered and calibrated unit. The heat exchanger, developed by the Burlington Refrigerator Express Co. operated satisfactorily and gives promise of adequate control of overheating of the liquid in the heating coils when circulation through the car is stopped by action of the control valve. Commodity temperatures during the test are graphed in Figure 4. This shows a normal spread between top and bottom temperatures for a non-fan car without heat until the heater was lit. Thereafter, the bottom temperatures rose until there was less than 1° difference between the average top and bottom by the end of the test. The maximum temperature at this point was in the fruit directly over the inlet to the pipe, indicating the need for more protection at this point. Table 13 summarizes the performance during transit.

In car E the Preco heaters were lit at Wenatchee and remained on pilot throughout the test. The curves in figure 6 show a gradual rise in commodity temperatures except for a slight drop when the coldest weather was encountered on March 1. The total heat from the pilots of both heaters averaged 1430 B.t.u. per hour, one producing 560 and the other 870 B.t.u./hour. Fan action during the time the car was moving resulted in uniform temperatures throughout the load (Fig. 6). The greatest difference between the average top and bottom commodity temperatures was less than 2°. Heater performance is tabulated in table 14.

No other heaters were lit and the commodity temperatures remained fairly constant in the other fan cars (B, D, F, and G) with a slight drop in each when the coldest weather occurred. (Figures 3, 5, 7, and 8.) As may be noted from the curves in these figures the average top and bottom temperatures were very close. In car H (non-fan) the maximum spread in temperature was 4.8°. There were no dangerously low or high commodity temperatures at any time during the transit period.

Table 11 is a compilation of the air temperatures within the cars B, C, and D as obtained from the thermal blister, liquidometer, and resistance thermometer readings. Except for the bottom blister, the position indicated is the same for all three types of thermometers. The resistance thermometer and liquidometer readings are in very close agreement for all positions in both cars C and D but there is quite a difference between the resistance thermometer and blister readings in car B. Differences in the bottom readings may be due in part to the different positions of each but the variation between the two top positions is such that it appears that the blister equipment was not giving a true reading.

The fruit in all of the cars was inspected when it was unloaded at destination. No freezing damage or overheating was reported in any of the cars.

Acknowledgments

This test was made possible by the companies and individuals listed below whose cooperation and assistance is gratefully acknowledged.

The commercial loads of apples used were provided by the following shippers:

Cashmere Fruit Growers Union, Cashmere, Washington
Cascadian Fruit Shippers, Wenatchee, Washington
Lake Chelan Fruit Growers, Chelan, Washington
Ninth Street Skookum Growers, Wenatchee, Washington
Wenatchee - Beebe Orchard Co., Brewster, Washington
Wenatchee - Beebe Orchard Co., Pateros, Washington

General arrangements for the test were made by Edwin Smith, U. S. D. A., Wenatchee, Washington.

The arrangements for handling the test cars and business car were made by H. D. McManus, Agent, Western Fruit Express, Wenatchee, Washington.

The business car for the accommodation of the test party was furnished by the Great Northern Railway. The G. N. Ry. and the C. B. & Q. RR provided the necessary extra handling of this car and the eight test cars.

Besides the members of the test party the following assisted in the loading and unloading of the test cars:

Edwin Smith - U. S. D. A., Wenatchee, Washington
David Adams - " " "
W. A. Radspinner, " , New York, N. Y.
S. A. Cole, A. A. R., Chicago, Illinois
WFE Agents at Cincinnati and Philadelphia

The Thermo-King units were provided, installed and serviced by the U. S. Thermo Control Co., Minneapolis.

The test cars equipped with underslung heaters were furnished by the Burlington Refrigerator Express Co. and the Thermo-King car and other cars by the Western Fruit Express Co.

The members of the test party were:

A. A. Hamer, Western Fruit Express Co., Alexandria, Va.
T. E. Wright, Bur. Plant Ind., Soils & Agricultural Engr., Wenatchee, Wash.
W. H. Redit, " " " " " " , Beltsville, Md.
L. J. Voegeli, Production and Marketing Administration, Washington, D. C.
E. A. Jones, Chief Engineer, U. S. Thermo Control Co., Minneapolis, Minn.
V. W. Snyder, Research Engineer, U. S. Thermo Control Co., " "

The following also accompanied the test between the points indicated:

H. L. Hudgens, Jr., Ass't. Perishable Freight Agent, CB&QRR, Breckenridge to Chicago.
W. E. Balfrey, Sales Manager, Luminator Inc., Wilmar to St. Paul

U. S. D. A. Heater Test No. 49-1

Loading Data

Table No. 1

Car	A-WFE 67564	B-FGE 40,000	C-BRE 74699	D-BRE 74698	E-FGE 56292	F-FGE 57676	G-FGE 56297	H-FGE 57545
Type	Non-fan	Fan	Overhead bunker	Fan	Fan	Fan	Fan	Standard Non-fan
Heater	Thermo-King	Mitchell Underslung	Mitchell Underslung	Mitchell Underslung	Preco	Simplex Thermo	Standard charcoal	Standard charcoal
Shipper	Wenatchee-Beebe	Cascadian Fruit Shippers	Lake Chelan Fruit Growers	Cashmere Fruit Growers Union	9th St. Skookum	Lake Chelan Fruit Growers	Lake Chelan Fruit Growers	Wenatchee-Beebe
Location	Pateros, Washington	Wenatchee, Washington	Chelan, Washington	Cashmere, Washington	Wenatchee, Washington	Chelan, Washington	Chelan, Washington	Brewster, Washington
Destination	Atlantic Comm. Co., Chicago, Ill.	American Stores Inc. Newark, N. J.	Victor Joseph New York, N.Y.	Atlantic Comm. Co., Youngstown, Ohio	Joseph E. Stein Cincinnati, O.	S. Albertson Company Chicago, Ill.	Fred Logan Company Philadelphia, Pa.	Atlantic Comm. Co. Chicago, Ill.
Routing	GN, CB&Q	GN, CB&Q, PRR	GN, CB&Q, PRR, Erie	GN, CB&Q, Erie	GN, CB&Q, Big 4	GN, CB&Q	GN, CB&Q, B&O	GN, CB&Q
Commodity	Apples	Apples	Apples	Apples	Apples	Apples	Apples	Apples
Variety	Winesap	Winesap	Delicious	Winesap	Golden Delicious Newtown	Delicious	Delicious	Winesap
Type loading	Braced	Braced	Braced	Solid	Solid	Braced	Braced	Solid
Brace opening	26"	26"	47"	none	none	26"	26"	none
No. Boxes	798	798	798	798	836	798	798	798
Billed Wt.	41,097	41,097	41,097	41,097	43,054	41,097	41,097	41,097
No. Stacks	19	19	22	21	21	19	19	19
No. Rows	7	7	7	7	7	7	7	7
No. Layers	6	6	6 and 5	13-6, 6-5, 2 on end	6and 5, 2 on end	6	6	6-5
Height of load	73-1/2"	74"	74", 61-1/4"	74", 61-1/2", 59 1/2"	74"-	74-1/2"	74"	74", 67-1/2", 62"
Space above load	16"	13-1/2"	10", 22-3/4"	17", 29-1/2", 31-1/2"	13"-	13"	13"	17-1/2", 24", 29-1/2"
Sidewall space	6-1/2"	4-1/2 - 6"	5-1/2 - 7"	5 - 6"	5 - 7"	5 - 7"	7-1/2"	7"
Sidewall flues or racks	Racks	Flues	Flues	None	None	None	None	None
Height of floor racks	4-3/4"	7-1/2"	6"	7-1/4"	7-1/2"	6-1/2"	7-1/2"	4-1/2"
Loading:								
Started	8:55 A.M.	8:15 A.M.	10:10 A.M.	8:30 A.M.	10:20 A.M.	7:15 A.M.	7:15 A.M.	10:30 A.M.
Completed	10:15 A.M.	9:45 A.M.	1:20 P.M.	10:10 A.M.	1:25 P.M.	9:30 A.M.	9:45 A.M.	1:30 P.M.
Average Temps:								
Commodity	32°	32°	34°	31°	33°	33°	33°	32°
Outside Air	35°	37°	42°	38°	43°	36°	36°	37°

Note: All cars loaded February 24.

Table No. 2

U. S. D. A. Test No. 40-1

Trip Log

Date	Station	Time Arrived	Time Departed	Elapsed Time	
				Running	Standing
Feb. 25	Appleyard	-	5:20 PM		
	Voltage	6:15	7:10	55	55
	Columbia River	7:20	7:45	10	25
	Trinidad	8:10	8:25	25	15
	Quincy	9:15	9:45	50	30
	Adrian	10:40	12:00M	55	1-20
26	Wilson Creek	12:40AM	2:50AM	40	2-10
	Lamona	4:20	4:35	1-30	15
	Edwall	6:30	6:40	1-55	10
	Hillyard	8:15	12:40PM	1-35	4-25
	Camden	1:25PM	1:45	45	20
	Scotia	2:10	2:45	25	35
	Sand Point	3:55	4:20	1-10	25
	Colburn	4:45	5:10	25	25
	Bonners Ferry	5:[illegible]5 PST	6:55 MST	45	60
	Troy	7:55	9:45	60	50
26-7	Ripley	10:50PM	12:30AM	1-05	1-40
27	Rexford	2:30AM	2:40	2-00	10
	Stryker	4:10	4:20	1-30	10
	Whitefish	5:15	12:25PM	55	7-10
	Brent	1:10	1:35	45	25
	Belton	2:10	2:30	35	20
	Essex	3:55	4:10	1-25	15
	Summit	5:20	6:15	1-10	55
	Blackfoot	7:55	8:25	1-40	30
	Shelby	9:50	10:05	1-25	15
	Buelow	11:35	11:50	1-30	15
28	Havre	12:55AM	7:00A	1-05	6-05
	Zurich	8:15	8:25	1-15	10
	Savoy	9:00	9:20	35	20
	Bowdoin	10:40	11:10	1-20	30
	Paisley	12:30PM	12:40PM	1-20	10
	Glasgow	12:55	1:20	15	25
	Frazer	2:15	2:30	55	15
	Wolf Point	3:00	3:40	30	40
	Lanark	5:25 MST	5:50 CST	1-45	25
March.	Williston	7:30P	2:30AM	1-40	6-00
1	Wheelock	3:35	4:35	1-05	60
	Ray	4:50	5:00	15	10
	White Earth	5:50	7:10	50	1-20
	Stanley	8:25	9:25	1-15	60
	Des Lacs	10:30	10:40	1-05	10

3-1	Minot	11:00AM	12:45PM	20	1-45
	Genoa	1:15PM	1:30	30	15
	Venendrye	1:50	2:10	20	20
	Aylmer	2:55	3:15	45	20
	Heimdal	4:00	4:20	45	20
	New Rockford	4:50	6:15	30	1-25
	Juanita	6:55	7:10	40	15
	Hannaford	7:55	8:15	45	20
	Nolan	9:15	9:30	1-00	15
	Kindred	11:15	11:25	1-45	10
3-2	Wahpetan Jct.	12:40AM	12:50AM	1-15	10
	Breckenridge	1:10	3:45	20	2-35
	Morris	5:50	6:00	2-05	10
	Wilmar	8:15	12:00N	2-15	3-45
	Dassel	1:35P	2:15	1-35	40
	Lyndale Jct.	3:45P	-	1-30	
	Daytons Bluff	-	9:30PM		5-45
3-3	N. LaCrosse	1:30A	2:15A	4-00	45
	Savanna	5:30	7:45	3-15	2-15
	Waterman	10:35	10:45	2-40	20
		11:00	11:20	15	20
	Congress Park	12:30	1:00	1-10	30
	Morton Park	1:15		15	
			Totals	70-30	67-25

Total elapsed time - 137-55

Table No. 3

U. S. D. A. Heater Test No. 49-1

Corrected Air and Commodity Temperatures

Commodity Apples Heater Thermo King Units Car No. A WFEX 67564

Station	Date	Time	OST °F.	Liquidometer 1/ Position Bott.	Top	TBCL H	TQCL H	TDCL	TQCL R	TBCL R	BBNS H	BQCL H	BDNS H	BDNS R	BBNS R	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
	Feb.	PST																	
Pateros	24					Loaded - 8:55 - 10:15 A.M.													
"	24	2:00PM	41	345	340	335	340	340	340	355	350	345	335	365	360	36.5	33.5	34.2	35.1
Appleyard	25	2:00PM	51	340	325	340	350	345	345	355	350	340	340	350	350	35.5	34.0	34.7	34.6
Quincy	25	9:00 "	34	340	365	340	345	345	345	350	345	350	340	355	350	35.5	34.0	34.5	34.8
Hillyard	26	8:30AM	38	330	305	340	345	340	335	345	345	350	340	345	345	35.0	33.5	34.1	34.5
Sand Point	26	4:00PM	43	320	290	325	340	330	335	335	330	340	335	335	330	34.0	32.5	33.3	33.4
		MST																	
Ripley	26	11:00PM	26	330	340	325	335	335	330	335	330	340	335	335	330	34.0	32.5	33.2	33.4
Whitefish	27	5:30AM	16	330	315	330	340	335	330	340	335	340	330	340	335	34.0	33.0	33.5	33.6
Whitefish	27	12:00N	35	320	325	325	335	330	330	335	325	340	330	335	330	34.0	32.5	33.1	33.2
Blackfoot	27	8:00PM	35	315	310	315	335	330	325	335	320	335	325	320	320	33.5	31.5	32.8	32.4
Havre	28	1:30AM	13	325	335	325	340	335	335	340	330	335	325	330	330	34.0	32.5	33.5	33.0
Bowdoin	28	11:00AM	18	315	325	325	335	330	330	335	325	335	325	325	330	33.5	32.5	33.1	32.8
Williston	28	8:00PM	18	315	330	320	335	335	330	335	320	330	325	325	320	33.5	32.0	33.1	32.4
	Mar.	CST																	
Minot	1	11:30AM	24	310	335	330	350	340	340	350	315	335	330	325	325	35.0	31.5	34.2	32.6
New Rockford	1	5:30PM	27	305	340	330	345	335	340	340	340	325	335	320	325	34.5	32.0	33.8	32.9
Breckenridge	2	1:30AM	22	315	310	335	345	345	345	345	325	330	345	330	335	34.5	32.5	34.3	33.3
Willmar	2	8:30AM	28	320	340	330	345	345	335	345	325	335	-	335	335	34.5	32.5	34.0	33.3
Daytons Blf.	2	7:30PM	30	320	340	335	350	345	340	350	330	335	335	335	335	35.0	33.0	34.4	33.4
Savanna	3	6:30AM	30	320	335	335	350	345	335	340	330	340	-	330	325	35.0	32.5	34.1	33.1
Morton Pk.	3	1:30PM	38	325	330	330	350	340	340	340	330	340	-	335	335	35.0	33.0	34.0	33.5

Note - Units in operation immediately after loading to 1:15 PM March 3 at Morton Park.

1/ Resistance thermometers placed adjacent to liquidometer bulbs.

Table No. 3

U. S. D. A. Heater Test No. 49-1

Corrected Air and Commodity Temperatures

Commodity Apples Heater Thermo King Units Car No. A WFEX 67564

Station	Date	Time	OST °F.	Liquidometer 1/ Position Bott.	Top	TBCL H	TQCL H	TDCL	TQCL R	TBCL R	BBNS H	BQCL H	BDNS H	BDNS R	BBNS R	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
	Feb.	PST																	
Pateros	24					Loaded - 8:55 - 10:15 A.M.													
"	24	2:00PM	41	345	340	335	340	340	340	355	350	345	335	365	360	36.5	33.5	34.2	35.1
Appleyard	25	2:00PM	51	340	325	340	350	345	345	355	350	340	340	350	350	35.5	34.0	34.7	34.6
Quincy	25	9:00 "	34	340	365	340	345	345	345	350	345	350	340	355	350	35.5	34.0	34.5	34.8
Hillyard	26	8:30AM	38	330	305	340	345	340	335	345	345	350	340	345	345	35.0	33.5	34.1	34.5
Sand Point	26	4:00PM	43	320	290	325	340	330	335	335	330	340	335	335	330	34.0	32.5	33.3	33.4
		MST																	
Ripley	26	11:00PM	26	330	340	325	335	335	330	335	330	340	335	335	330	34.0	32.5	33.2	33.4
Whitefish	27	5:30AM	16	330	315	330	340	335	330	340	335	340	330	340	335	34.0	33.0	33.5	33.6
Whitefish	27	12:00N	35	320	325	325	335	330	330	335	325	340	330	335	330	34.0	32.5	33.1	33.2
Blackfoot	27	8:00PM	35	315	310	315	335	330	325	335	320	335	325	320	320	33.5	31.5	32.8	32.4
Havre	28	1:30AM	13	325	335	325	340	335	335	340	330	335	325	330	330	34.0	32.5	33.5	33.0
Bowdoin	28	11:00AM	18	315	325	325	335	330	330	335	325	335	325	325	330	33.5	32.5	33.1	32.8
Williston	28	8:00PM	18	315	330	320	335	335	330	335	320	330	325	325	320	33.5	32.0	33.1	32.4
	Mar.	CST																	
Minot	1	11:30AM	24	310	335	330	350	340	340	350	315	335	330	325	325	35.0	31.5	34.2	32.6
New Rockford	1	5:30PM	27	305	340	330	345	335	340	340	340	325	335	320	325	34.5	32.0	33.8	32.9
Breckenridge	2	1:30AM	22	315	310	335	345	345	345	345	325	330	345	330	335	34.5	32.5	34.3	33.3
Willmar	2	8:30AM	28	320	340	330	345	345	335	345	325	335	-	335	335	34.5	32.5	34.0	33.3
Daytons Blf.	2	7:30PM	30	320	340	335	350	345	340	350	330	335	335	335	335	35.0	33.0	34.4	33.4
Savanna	3	6:30AM	30	320	335	335	350	345	335	340	330	340	-	330	325	35.0	32.5	34.1	33.1
Morton Pk.	3	1:30PM	38	325	330	330	350	340	340	340	330	340	-	335	335	35.0	33.0	34.0	33.5

Note - Units in operation immediately after loading to 1:15 PM March 3 at Morton Park.

1/ Resistance thermometers placed adjacent to liquidometer bulbs.

Table No. 4

U. S. D. A. Heater Test No. 49-1

Corrected Air and Commodity Temperatures

Commodity Apples Heater Mitchel Underslung Charcoal Car No. B FGE 40,000(Fan Car)

Station	Date	Time	OST	Liquidometer Position 1/		TBCL	TQCL	TDCL	TQCL	TBCL	BBNS	BQCL	BDNS	BDNS	BBNS	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
			°F.	Bott.	Top	H	H		R	R	H	H	H	R	R				
	Feb.	PST																	
Wenatchee	24	-						Loaded 8:15 - 9:45 A.M.											
"	24	11:00AM	39	-	420	395	380	380	390	385	395	360	380	375	380	39.5	36.0	38.6	37.8
Appleyard	25	3:00PM	52	-	440	395	395	390	390	390	360	345	365	370	360	39.5	34.5	39.2	36.0
Quincy	25	9:00PM	34	-	400	400	395	400	400	395	390	370	390	390	385	40.0	37.0	39.8	38.5
Millyard	26	8:30AM	38	380	380	380	400	380	395	385	375	360	380	380	380	40.0	36.0	38.8	37.5
Sand Point	26	4:00PM	43	395	430	400	-	405	415	405	395	370	400	400	400	41.5	37.0	40.6	39.3
		MST																	
Ripley	26	11:00PM	26	395	400	395	390	400	410	405	395	370	400	-	400	41.0	37.0	40.0	39.1
Whitefish	27	5:30AM	16	375	380	385	-	390	395	395	385	370	380	390	395	39.5	37.0	39.1	38.4
Whitefish	27	12:00N	35	360	380	385	-	390	395	390	375	370	385	385	380	39.5	37.0	39.0	37.9
Blackfoot	27	8:00PM	35	380	400	390	-	400	395	385	385	375	385	395	385	40.0	37.5	39.3	38.5
Havre	28	1:30AM	18	375	390	390	-	395	395	395	390	380	385	390	390	39.5	38.0	39.4	38.7
Bowdoin	28	11:00AM	18	365	380	380	-	380	395	385	375	375	375	375	380	39.5	37.5	38.5	37.6
Lanark	28	5:30PM	28	375	395	390	-	390	395	385	380	380	380	385	380	39.5	38.0	39.0	38.1
Williston	28	8:00PM	18	375	385	390	-	390	395	390	385	380	385	385	385	39.5	38.0	39.1	38.4
	Mar.	CST																	
Minot	1	11:30AM	24	345	360	370	-	370	375	365	355	365	360	355	360	37.5	35.5	37.0	35.9
New Rockford	1	5:30PM	27	370	385	380	-	380	385	380	365	370	370	370	365	38.5	36.5	38.1	36.8
Breckenridge	2	1:30AM	22	365	380	380	-	380	390	385	375	375	375	375	375	39.0	37.5	38.4	37.5
Willmar	2	8:30AM	28	360	380	380	-	380	390	385	375	375	375	375	370	39.0	37.0	38.4	37.4
Daytons Blf.	2	7:30PM	30	365	380	380	-	380	390	380	375	375	375	375	370	39.0	37.0	38.3	37.4
Savanna	3	6:30AM	30	380	395	390	-	390	395	385	385	380	385	385	380	39.5	38.0	39.0	38.3
Morton Pk.	3	1:30PM	38	385	400	400	-	400	395	395	395	380	390	395	390	40.0	38.0	39.8	39.0

1/ Resistance thermometers placed adjacent to liquidometer bulbs.

Table No. 5

U. S. D. A. Heater Test No. 49-1

Corrected Air and Commodity Temperatures

Commodity Apples Heater Mitchel Underslung Charcoal Car No. C BREX 74699 (Overhead bunker

Station	Date	Time	OST	Liquidometer Positions 1/		TBCL	TQCL	TDCL	TQCL	TBCL	BBNS	BQCL	BDNS	BDNS	BBNS	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
			°F.	Bott.	Top	H	H		R	R	H	H	H	R	R				
	Feb.	PST																	
Chelan	24								Loaded 10:10 A.M. to 1:20 P.M.										
Appleyard	25	3:00PM	52	350	435	390	380	390	375	375	355	365	360	365	360	39.0	35.5	38.2	36.1
Quincy	25	9:00PM	34	375	440	415	410	420	400	400	380	385	395	390	385	42.0	38.0	40.9	38.7
Hillyard	26	8:30AM	38	365	385	405	395	395	390	390	370	375	370	380	375	40.5	37.0	39.5	37.4
Sand Point	26	4:00PM	43	365	460	410	405	405	395	400	370	375	375	380	380	41.0	37.0	40.3	37.6
		MST																	
Ripley	26	11:00PM	26	365	420	405	410	400	395	405	375	375	380	390	385	41.0	37.5	40.3	38.1
Whitefish	27	5:30AM	16	355	380	405	400	400	395	390	360	375	360	370	370	40.5	36.0	39.8	36.7
Whitefish	27	12:00N	35	345	370	395	390	385	385	380	350	370	345	360	355	39.5	34.5	38.7	35.6
Blackfoot	27	8:00P	35	350	415	405	405	400	395	395	360	370	360	365	365	40.5	36.0	40.0	36.4
Havre	28	1:30AM	18	360	385	405	380	400	395	390	360	380	360	365	370	40.5	36.0	39.4	36.7
Bowdoin	28	11:00AM	18	340	360	395	390	380	380	385	340	370	340	345	345	39.5	34.0	38.6	34.8
Williston	28	8:00PM	18	345	380	400	395	390	385	380	355	370	350	350	355	40.0	35.0	39.0	35.6
Minot	Mar. 1	11:30AM	CST	24°F.					Heater lighted										
Minot	1	11:30AM	24	295	340	385	370	365	365	350	320	355	300	310	320	38.5	30.0	36.7	32.1
New Rockford	1	5:30PM	27	365	400	385	380	380	375	360	330	350	320	340	335	38.5	32.0	37.6	33.5
Breckenridge	2	1:30AM	22	400	400	400	390	395	395	390	355	370	360	390	365	40.0	35.5	39.4	36.8
Willmar	2	8:30AM	28	385	380	390	390	385	385	380	345	375	360	395	365	39.5	34.5	38.6	36.8
Daytons Blf.	2	7:30PM	30	405	380	385	390	390	385	380	360	380	385	410	365	41.0	36.0	38.6	38.0
Savanna	3	6:30AM	30	390	380	390	390	390	385	380	360	385	400	435	370	43.5	36.0	38.7	39.0
Morton Pk.	3	1:30PM	38	385	390	395	390	395	390	380	365	385	405	440	380	44.0	36.5	39.0	39.5

1/ Resistance thermometers placed adjacent to liquidometer bulbs.

Table No. 6

U. S. D. A. Heater Test No. 49-1

Corrected Air and Commodity Temperatures

Commodity Apples Heater Mitchel Underslung Charcoal Car No. D BREX 74698 (Fan Car)

Station	Date	Time	OST	Liquidometer Position 1/		TBCL	TQCL	TDCL	TQCL	TBCL	BBNS	BQCL	BDNS	BDNS	BBNS	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
			°F.	Bott.	Top	H	H		R	R	H	H	H	R	R				
	Feb.	PST																	
Cashmere	24								Loaded 8:30 - 10:10 AM										
Cashmere	24	11:30AM	40	405	450	380	365	360	380	405	365	335	345	375	370	40.5	37.5	37.8	35.8
Appleyard	25	3:00PM	51	330	405	360	360	355	365	365	340	320	340	350	345	36.5	32.0	36.1	33.9
Quincy	25	9:00PM	34	340	370	360	355	360	360	360	350	325	350	350	355	36.0	32.5	35.9	34.6
Hillyard	26	8:30AM	38	340	340	345	345	340	345	345	340	330	340	340	345	34.5	32.0	34.4	33.9
Sand Point	26	4:00PM	43	345	385	355	355	360	360	360	350	330	345	355	355	36.0	33.0	35.8	34.7
		MST																	
Ripley	26	11:00PM	26	350	360	360	360	360	360	360	355	340	350	360	360	36.0	34.0	36.0	35.3
Whitefish	27	5:30AM	16	345	335	350	350	345	350	350	345	335	345	350	350	35.0	33.5	34.9	34.5
Whitefish	27	12:00N	35	320	340	340	345	340	345	345	320	330	340	335	330	34.5	32.0	34.3	33.1
Blackfoot	27	8:00PM	35	345	355	345	350	355	355	355	340	340	345	350	350	35.5	34.0	35.2	34.5
Havre	28	1:30AM	18	350	340	355	350	350	350	350	350	340	350	345	350	35.5	34.0	35.1	34.7
Bowdoin	28	11:00AM	18	335	330	340	340	340	345	345	330	340	335	335	335	34.5	33.0	34.2	33.5
Williston	28	8:00PM	18	345	345	345	350	350	350	350	340	340	345	345	350	35.0	34.0	34.9	34.4
	Mar.	CST																	
Minot	1	11:30AM	24	325	315	330	330	330	335	335	310	340	325	315	325	34.0	31.0	33.2	32.3
New Rockford	1	5:30PM	27	340	355	340	340	340	340	340	330	340	330	335	335	34.0	33.0	34.0	33.4
Breckenridge	2	1:30AM	22	340	340	340	345	340	340	345	330	340	335	335	335	34.5	33.0	34.2	33.5
Willmar	2	8:30AM	28	340	340	340	345	340	340	340	330	345	335	335	340	34.5	33.0	34.1	33.7
Laytons Blf.	2	7:30PM	30	345	345	345	345	345	345	345	330	345	335	340	345	34.5	33.0	34.5	33.9
Savanna	3	6:30AM	30	355	360	355	360	355	360	360	355	350	355	355	360	36.0	35.0	35.8	35.5
Morton Pk.	3	1:30PM	38	355	365	360	360	360	360	360	355	350	355	360	360	36.0	35.0	36.0	35.6

1/ Resistance thermometers placed adjacent to liquidometer bulbs.

Table No. 7

U. S. D. A. Heater Test No. 49-1

Corrected Air and Commodity Temperatures

Commodity Apples Heater Preco Alcohol Heater Car No. E FGE 56292 (Fan Car)

Station	Date	Time	OST	Liquidometer Position 1/		TBCL	TQCL	TDCL	TQCL	TBCL	BBNS	BQCL	BDNS	BDNS	BBNS	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
			°F.	Bott.	Top	H	H		R	R	H	H	H	R	R				
Wenatchee	Feb.	24 PST							Loaded 10:20AM to 1:25PM										
Wenatchee	24	1:30PM	44	375	415	395	380	405	390	400	375	370	380	365	380	40.5	36.5	39.4	37.4
Appleyard	25	3:00PM	51	350	395	380	370	375	380	380	360	355	360	355	365	38.0	35.5	37.7	35.9
Appleyard	25	5:15PM							Pilots Lit										
Quincy	25	9:00PM	34	370	405	390	380	390	390	400	370	370	380	375	380	40.0	37.0	39.0	37.5
Hillyard	26	8:30AM	38	375	390	385	380	385	390	405	375	370	385	380	380	40.5	37.0	38.9	37.8
Sand Point	26	4:00PM	43	385	420	400	390	400	405	415	390	380	395	395	390	41.5	38.0	40.2	39.0
		MST																	
Ripley	26	11:00PM	26	390	410	400	395	400	405	415	395	375	405	400	400	41.5	37.5	40.3	39.5
Whitefish	27	5:30AM	16	390	395	400	395	395	405	415	390	390	395	395	400	41.5	39.0	40.2	39.4
Whitefish	27	12:00N	35	375	390	400	385	390	405	415	375	385	380	375	385	41.5	37.5	39.9	38.9
Blackfoot	27	8:00PM	35	395	405	400	395	405	410	420	395	395	400	400	400	42.0	39.5	40.6	39.8
Havre	28	1:30AM	18	395	400	405	400	400	410	415	395	400	405	400	405	41.5	39.5	40.6	40.1
Bowdoin	28	11:00AM	18	395	395	400	395	395	405	415	390	395	395	395	395	41.5	39.0	40.2	39.4
Williston	28	8:00PM	18	400	405	405	400	405	410	425	395	400	405	400	405	42.5	39.5	40.9	40.1
	Mar.	CST																	
Minot	1	11:30AM	24	390	385	400	390	390	400	415	375	395	385	385	385	41.5	37.5	39.3	38.5
New Rockford	1	5:30PM	27	405	405	400	400	400	405	415	385	395	400	395	395	41.5	38.5	40.4	39.4
Breckenridge	2	1:30AM	22	405	405	410	400	405	415	430	395	400	405	405	405	43.0	39.5	41.2	40.2
Willmar	2	8:30AM	28	405	405	410	405	405	415	425	400	405	405	405	405	42.5	40.0	41.2	40.4
Daytons Blf.	2	7:30PM	30	405	410	420	410	410	420	435	395	405	410	405	410	43.5	39.5	41.9	40.5
Savanna	3	6:30AM	30	420	430	420	420	420	430	440	420	415	425	425	425	44.0	41.5	42.6	42.2
Morton Pk.	3	1:30PM	38	420	430	425	425	430	435	445	425	420	430	430	430	44.5	42.0	43.2	42.7

1/ Resistance thermometers placed adjacent to liquidometer bulbs

Table No. 8

U. S. D. A. Heater Test No. 49-1

Corrected Air and Commodity Temperatures

Commodity Apples Heater Simplex Thermo Charcoal Heaters Car No. F FGE 57676 (Fan Car)

Station	Date	Time	OST	Liquidometer Position 1/		TBCL	TQCL	TDCL	TQCL	TBCL	BBNS	BQCL	BDNS	BDNS	BBNS	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
			°F.	Bott.	Top	H	H		H	H	H	H	H	R	R				
	Feb.	PST																	
Chelan	24							Loaded 7:15 - 9:30 A.M.											
Appleyard	25	3:00PM	51	350	400	400	380	-	380	380	370	350	355	365	355	40.0	35.0	38.5	35.9
Quincy	25	9:00PM	34	370	390	390	385	-	380	380	375	345	365	385	375	39.0	34.5	38.4	36.9
Hillyard	26	8:30AM	38	360	365	385	375		370	375	380	360	360	375	370	38.5	36.0	37.6	36.9
Sand Point	26	4:00PM	43	375	395	390	380		380	380	385	365	370	385	375	39.0	36.5	38.3	37.6
		MST																	
Ripley	26	11:00PM	26	380	390	390	385		385	385	390	365	380	395	385	39.5	36.5	38.6	38.1
Whitefish	27	5:30AM	16	390	380	390	380		380	375	385	370	360	385	380	39.0	36.0	37.1	37.6
Whitefish	27	12:00N	35	355	365	385	370		370	375	370	370	355	365	365	38.5	34.5	37.5	36.5
Blackfoot	27	8:00PM	35	375	380	390	375		380	380	375	370	365	385	370	39.0	36.5	38.1	37.3
Havre	28	1:30AM	18	375	375	390	380		385	385	385	375	370	390	375	39.0	37.0	38.5	37.9
Bowdoin	28	11:00AM	18	370	365	385	375		375	375	375	375	360	380	370	38.5	36.0	37.8	37.2
Lanark	28	5:30PM	28	385	385	395	385		385	385	380	385	375	390	380	39.5	37.5	38.8	38.2
Williston	28	8:00PM	18	380	375	395	380		380	385	385	380	370	385	380	39.5	37.0	38.5	38.0
	Mar.	CST																	
Minot	1	11:30AM	24	355	350	375	365		365	370	360	380	345	360	355	38.0	34.5	36.9	36.0
New Rockford	1	5:30PM	27	365	380	380	375		370	370	370	375	355	370	355	38.0	35.5	37.4	36.5
Breckenridge	2	1:30AM	22	370	365	390	380		370	380	370	375	355	375	360	39.0	35.5	38.0	36.7
Willmar	2	8:30AM	28	370	365	385	380		370	375	375	380	355	375	360	38.5	35.5	37.8	36.9
Daytons Blf.	2	7:30PM	30	370	365	385	380		375	375	370	380	355	375	360	38.5	35.5	37.9	36.8
Savanna	3	6:30AM	30	385	385	400	390		385	390	390	390	375	390	380	40.0	37.5	39.1	38.5
Morton Pk.	3	1:30PM	38	390	390	400	390		390	395	395	390	385	395	385	40.0	38.5	39.4	39.0

1/ Resistance thermometers placed adjacent to liquidometer bulbs.

Table No. 9

U. S. D. A. Heater Test No. 49-1

Corrected Air and Commodity Temperatures

Commodity Apples Heater Standard Charcoal Heater Car No. G FGE 56297 (Fan Car)

Station	Date	Time	OST	Liquidometer Position 1/		TBCL	TQCL	TDCL	TQCL	TBCL	BBNS	BQCL	BDNS	BDNS	BBNS	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
			°F.	Bott.	Top	H	H		R	R	H	H	H	R	R				
	Feb.	PST																	
Chelan	24								Loaded 7:15 - 9:45 A.M.										
Appleyard	25	3:00PM	51	355	405	375	400	385	370	360	360	355	365	375	345	40.0	34.5	37.8	36.0
Quincy	25	9:00PM	34	370	395	375	405	395	385	365	370	365	380	390	360	40.5	36.0	38.5	37.3
Hillyard	26	8:30AM	38	360	370	370	395	385	370	355	370	365	370	375	355	39.5	35.5	37.5	36.7
Sand Point	26	4:00PM	43	380	400	375	400	395	375	360	375	365	380	390	360	40.0	36.0	38.1	37.4
		MST																	
Ripley	26	11:00PM	26	380	390	385	405	400	375	365	380	370	385	395	365	40.5	36.5	38.6	37.9
Whitefish	27	5:30AM	16	370	375	375	400	390	380	360	375	370	380	380	365	40.0	36.0	38.1	37.4
Whitefish	27	12:00N	35	350	365	370	395	375	370	350	360	370	360	370	350	39.5	35.0	37.2	36.2
Blackfoot	27	8:00PM	35	370	385	375	410	395	380	355	370	375	375	380	360	41.0	35.5	38.3	37.2
Havre	28	1:30AM	18	325	380	375	405	395	375	360	375	375	375	385	365	40.5	36.0	38.2	37.5
Bowdoin	28	11:00AM	18	370	370	370	405	385	370	355	365	375	370	380	355	40.5	35.5	37.7	36.9
Lanark	28	5:30PM	28	370	380	375	410	390	375	360	370	380	370	380	360	41.0	36.0	38.2	37.2
Williston	28	8:00PM	18	370	380	375	405	395	380	360	370	375	375	385	365	40.5	36.0	38.3	37.4
	Mar.	CST																	
Minot	1	11:30AM	24	350	350	360	395	375	360	345	350	370	355	360	340	39.5	34.0	36.7	35.5
New Rockford	1	5:30PM	27	365	370	365	395	385	370	350	360	375	360	370	345	39.5	34.5	37.3	36.2
Breckenridge	2	1:30AM	22	365	370	370	395	390	370	355	360	375	355	375	350	39.5	35.0	37.6	36.3
Willmar	2	8:30AM	28	365	370	370	395	385	375	360	365	380	365	375	350	39.5	35.0	37.7	36.7
Daytons Blf.	2	7:30PM	30	365	365	365	400	390	375	350	365	375	360	375	355	40.0	35.0	37.6	36.6
Savanna	3	6:30AM	30	380	385	380	415	405	385	370	385	390	380	390	370	41.5	37.0	39.1	38.3
Morton Pk.	3	1:30PM	38	390	390	390	415	405	390	370	390	390	380	395	375	41.5	37.0	39.4	38.6

1/ Resistance thermometers placed adjacent to liquidometer bulbs.

Table No. 10

U. S. D. A. Heater Test No. 49-1

Corrected Air and Commodity Temperatures

Commodity Apples Heater Standard Charcoal Heater Car No. H FGE 57545 (Non-Fan Car)

Station	Date	Time	CST	Liquidometer Position 1/		TBCL	TQCL	TDCL	TQCL	TBCL	BBNS	BQCL	BDNS	BDNS	BBNS	MAX.	MIN.	AVE. TOPS	AVE. BOTT.
			°F.	Bott.	Top	H	H		R	R	H	H	H	R	R				
	Feb.	PST																	
Brewster	24								Loaded 10:30 A.M. to 1:30 P.M.										
Brewster	24	1:30PM	41	360	395	345	360	350	345	360	360	350	345	345	345	36.0	34.5	35.2	34.9
Appleyard	25	3:00PM	51	340	410	365	375	375	365	365	365	345	345	345	350	37.5	34.5	36.9	35.0
Quincy	25	9:00PM	34	345	415	370	390	395	380	380	385	350	350	350	355	39.5	35.0	38.3	35.8
Hillyard	26	8:30AM	38	345	370	370	385	385	375	370	370	350	350	350	355	38.5	35.0	37.7	35.5
Sand Point	26	4:00PM	43	350	435	385	400	400	385	390	375	355	350	350	360	40.0	35.0	39.2	35.8
		MST																	
Ripley	26	11:00PM	26	355	405	385	395	400	385	380	375	355	350	360	360	40.0	35.0	38.9	36.0
Whitefish	27	5:30AM	16	350	365	375	390	395	380	380	375	355	355	355	365	39.5	35.5	38.4	36.1
Whitefish	27	12:00N	35	335	360	365	380	375	370	365	360	350	340	340	350	38.0	34.0	37.1	34.8
Blackfoot	27	8:00PM	35	335	400	375	385	395	385	385	365	355	340	340	345	39.5	34.0	38.5	34.9
Havre	28	1:30AM	18	345	375	375	390	395	380	380	370	355	340	340	350	39.5	34.0	38.4	35.1
Bowdoin	28	11:00AM	18	335	355	365	385	390	380	380	360	355	340	335	340	39.0	33.5	38.0	34.6
Lanark	28	5:30PM	28	330	375	365	385	385	370	365	355	350	330	330	340	38.5	33.0	37.4	34.1
Williston	28	8:00PM	18	330	370	365	385	385	375	370	360	350	330	330	340	38.5	33.0	37.6	34.2
	Mar.	CST																	
Minot	1	11:30AM	24	310	335	355	375	370	365	360	340	345	310	310	325	37.5	31.0	36.5	32.6
New Rockford	1	5:30PM	27	305	380	355	375	375	365	360	340	340	310	305	320	37.5	30.5	36.6	32.3
Breckenridge	2	1:30AM	22	310	355	355	375	380	365	360	335	330	305	305	320	38.0	30.5	36.7	31.9
Willmar	2	8:30AM	28	315	355	355	375	380	365	360	350	340	315	310	330	38.0	31.0	36.7	32.9
Daytons Blf.	2	7:30PM	30	320	355	350	370	370	365	350	345	335	315	315	320	37.0	31.5	36.1	33.6
Savanna	3	6:30AM	30	325	365	355	380	380	365	360	360	350	325	325	335	38.0	32.5	36.8	33.9
Morton Pk.	3	1:30PM	38	335	370	355	380	385	370	360	355	350	330	330	340	38.5	33.0	36.8	34.1

1/ Resistance thermometers placed adjacent to liquidometer bulbs.

Table No. 11

CAR AIR TEMPERATURES

Liquidometer, Thermal Blister & Resistance Thermometer Readings

Place	Date	Time	CST	B FGE [illegible]				C BRE 74690				D BRE 74692			
				Thermo-Blister		Res. Therm.		Liquidometer		Res. Therm.		Liquidometer		Res. Therm.	
			°F	Top 1/	Bot 1/	Top 2/	Bot 2/	Top 3/	Bot 4/	Top	Bot 2/	Top	Bot.	Top	Bot.
Quincy 5/	2-25	9:00P	34	39.0	38.0	40.0	-	42.5	35.5	44.0	37.5	37.0	34.0	37.0	34.0
Hillyard	2-26	8:30A	38	37.0	34.0	38.0	38.0	37.5	35.5	38.5	36.5	37.5	37.5	34.0	34.0
Sand Point	"	4:00P	43	40.0	39.5	43.0	39.5	44.5	35.5	46.0	36.5	39.0	34.5	38.5	34.5
Ripley	"	11:00P	26	36.0	38.0	40.0	39.5	41.0	36.0	42.0	36.5	35.5	34.5	36.0	35.0
Whitefish	2-27	5:30A	16	34.0	34.0	38.0	37.5	37.0	35.0	38.0	35.5	32.5	34.0	37.5	34.5
Whitefish	"	12:00N	35	32.0	30.5	38.0	36.0	36.0	33.5	37.0	34.5	37.0	37.5	34.0	32.0
Blackfoot	"	8:00P	35	36.0	36.0	40.0	38.0	40.5	34.5	41.5	35.0	35.5	34.0	35.5	34.5
Havre	2-28	1:30A	18	34.0	33.0	39.0	37.5	38.0	34.5	38.5	36.0	34.0	34.5	34.0	35.0
Bowdoin	"	11:00A	18	31.0	30.5	38.0	36.5	34.5	32.5	36.0	34.0	32.0	34.0	37.0	37.5
Williston	"	8:00P	18	33.5	32.5	38.5	37.5	36.5	32.5	38.0	34.5	34.0	34.5	34.5	34.5
Minot	3-1	11:30A	24	29.5	28.0	36.0	34.5	33.5	29.5	34.0	29.5	30.0	33.5	31.5	32.5
N. Rockford	"	5:30P	27	34.0	32.0	38.5	37.0	38.5	34.5	40.0	36.5	34.5	34.0	35.5	34.0
Breckenridge	3-2	1:30A	22	32.0	32.0	38.0	36.5	39.0	39.0	40.0	40.0	33.0	34.0	34.0	34.0
Willmar	"	8:00A	28	32.0	32.0	38.0	36.0	38.0	38.0	38.0	38.5	33.0	34.0	34.0	34.0
Daytons Bluff	"	7:30P	30	33.0	33.0	38.0	36.5	38.0	40.0	38.0	40.5	34.0	34.5	34.5	34.5
Savanna	3-3	6:30A	30	34.5	35.0	39.5	38.0	37.5	39.5	38.0	39.0	35.5	35.5	36.0	35.5
Morton Park	"	1:30P	38	35.5	36.0	40.0	38.5	38.5	39.0	39.0	38.5	36.0	36.0	36.5	35.5

1/ Bottom blister located at door post, north side, 1" above floor rack.
2/ Resistance thermometer located at centerline, doorway under floor rack.
3/ All top positions - centerline doorway at ceiling - Blister flush with plywood - Liquidometer and resistance thermometer 1" below ceiling.
4/ Liquidometer bottom bulb under floor rack at centerline doorway position.
5/ No reading on blister or Liquidometers at Appleyard.

Table No. 12

U. S. D. A. Test No. 49-1

Heater Inspection Data

Test Code No. A — Thermostat Setting 31° & 30° — Heater Thermo-King

Car No. WFE 5754 — Built-in Fans — No drains — Placement A End

Unit started at loading time morning of February 24 at Pateros.

Fuel pump removed on unit A and adjustments made on unit B at Pateros.

Thermostat setting 31° at start of test. Changed to 30° at Hillyard.

3° differential between thermostat bulb temperature (return air) and commodity resulted in an average of 33° commodity temperature.

Quincy, Washington 2/25 - Fuel pump on unit A replaced.

Sand Point, Idaho 2/26 - Fan belt replaced due to damage resulting from previous change of fuel pump. Original fuel pump cleaned and replaced in unit A at this location. Voltage regulator adjusted.

Morton Park, Chicago - Both units shut off upon arrival (1:15p.m.) and fuel tanks refilled to determine fuel consumption.

Unit A - 7-3/4 gals. 16 to 17 hours operation (from engine hour meter)

Unit B - 9 gals. 18 to 19 " " " " " "

Total - 16-3/4 gallons, 34-36 hours operation

Units were operated at approximately 2° differential of thermostat settings.

Table No. 13

U. S. D. A. Test No. 49-1

Heater Inspection Data

Test Code No. C — Thermostat Setting Approx. 36° — Heater Luminator-Mitchel

Car No. BREX 74699 — Overhead Bunker Car Drains Plugged — Placement center car under floor

Inspected at	Date	Time	Liquidometer 1/ Position Bott.	Liquidometer 1/ Position Top	Operation	Lbs. fuel added	Lbs. fuel in heater	Total fuel consumed	Remarks
Appleyard	2-24	-	-	-	D	-	30#	-	-
Minot	3-1	11:30AM	29.5	34.0	Lighted	-	-	-	Damper at 4
Nolan	3-1	9:15PM	39.5	40.5	B	-	-	-	Lowered thermo. 2°
Willmar	3-2	8:30AM	38.5	38.0	D re-lit	20	-	-	Out for only 1hr
Dayton's Bluff	3-2	7:30PM	40.5	38.0	B	20	-	-	-
Savanna	3-3	6:30AM	39.0	38.0	B	20	-	-	Thermo. setting reduced 2°
Morton Park	3-3	1:30PM	38.5	39.0	B	-	10#	80#	-

Draft setting placed on 0 at Morton Park

Note: D = Dark
B = Burning

1/ Resistance thermometer bulbs placed adjacent to top and bottom liquidometer positions.

Table No. 14

U. S. D. A. Test No. 49-1

Heater Inspection Data

Test Code No. E Thermostat Setting 32 1/2° Heater Preco
Car No. FGE 56292 Fans On Drains Open Diagonally Placement Each End

Inspected at	Date	Time	OST °F.	Thermostat temperature H	Thermostat temperature R	Burner Operation H	Burner Operation R	Gals. fuel added H	Gals. fuel added R	Gals. fuel in heater H	Gals. fuel in heater R	Fuel consumed from last inspection H	Fuel consumed from last inspection R	Estimated hrs. main burner on last insp. H	Estimated hrs. main burner on last insp. R
						Pilots lit									
Appleyard	2-25	5:15PM	51	-	-			-	-	3.37	3.75	-	-	-	-
Quincy	2-25	9:00PM	34	36.0	36.5	P	P	-	-	-	-	-	-	-	-
Hillyard	2-26	8:30AM	38	37.0	37.5	P	P	-	-	-	-	-	-	-	-
Sand Point	2-26	4:00PM	43	38.5	39.5	P	P	-	-	-	-	-	-	-	-
Ripley	2-26	11:00PM	26	38.5	39.5	P	P	-	-	-	-	-	-	-	-
Whitefish	2-27	5:30AM	16	38.5	38.5	P	P	-	-	3.00	3.20	.37	.55	-	-
Whitefish	2-27	12:00N	35	36.5	37.0	P	P	-	-	-	-	-	-	-	-
Blackfoot	2-27	8:00PM	35	38.5	39.0	P	P	-	-	-	-	-	-	-	-
Havre	2-28	1:30AM	18	39.5	39.5	P	P	-	-	2.90	2.95	.10	.25	-	-
Williston	2-28	8:00PM	18	39.5	40.0	P	P	-	-	2.80	2.70	.10	.25	-	-
Wilmar	3-2	8:30AM	28	39.5	40.0	P	P	-	-	2.45	2.20	.35	.50	-	-
Dayton's Bluff	3-2	7:30PM	30	40.0	40.0	P	P	-	-	2.28	2.10	.17	.10	-	-
Morton Park	3-3	2:00PM	38	42.0	42.5	P	P	-	-	2.15	1.85	.13	.25	-	-
		Pilots Extinguished													
									Totals	1.22	1.90	1.22	1.90	-	-

Total pilot burning time 138.75 hours
Pilot Burning Rate:
Gals/hr. .0088 .0137
Btu/hr. 560 870

USDA HEATER TEST 49-1
FIGURE NO. 1
OUTSIDE AIR TEMPERATURE

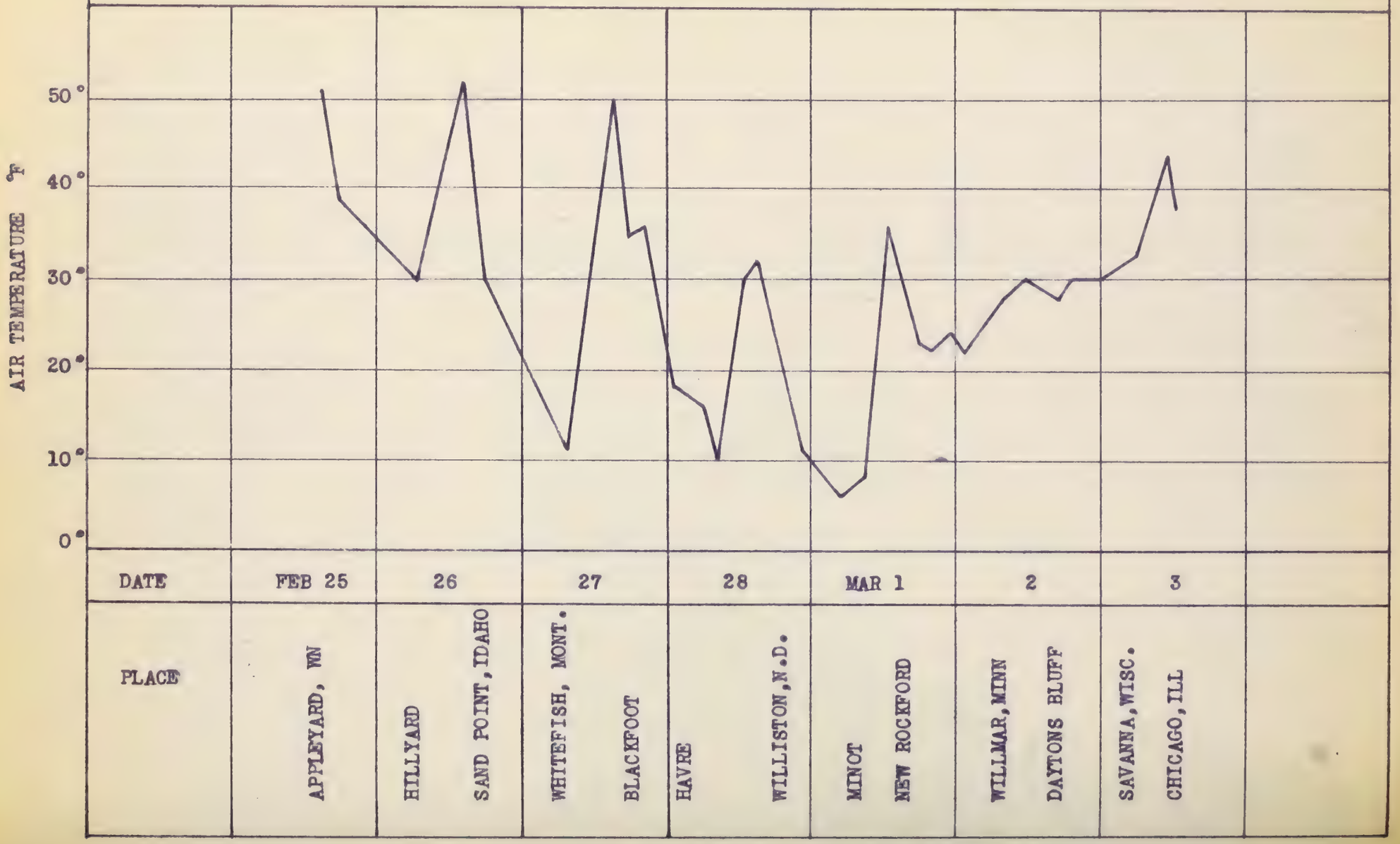
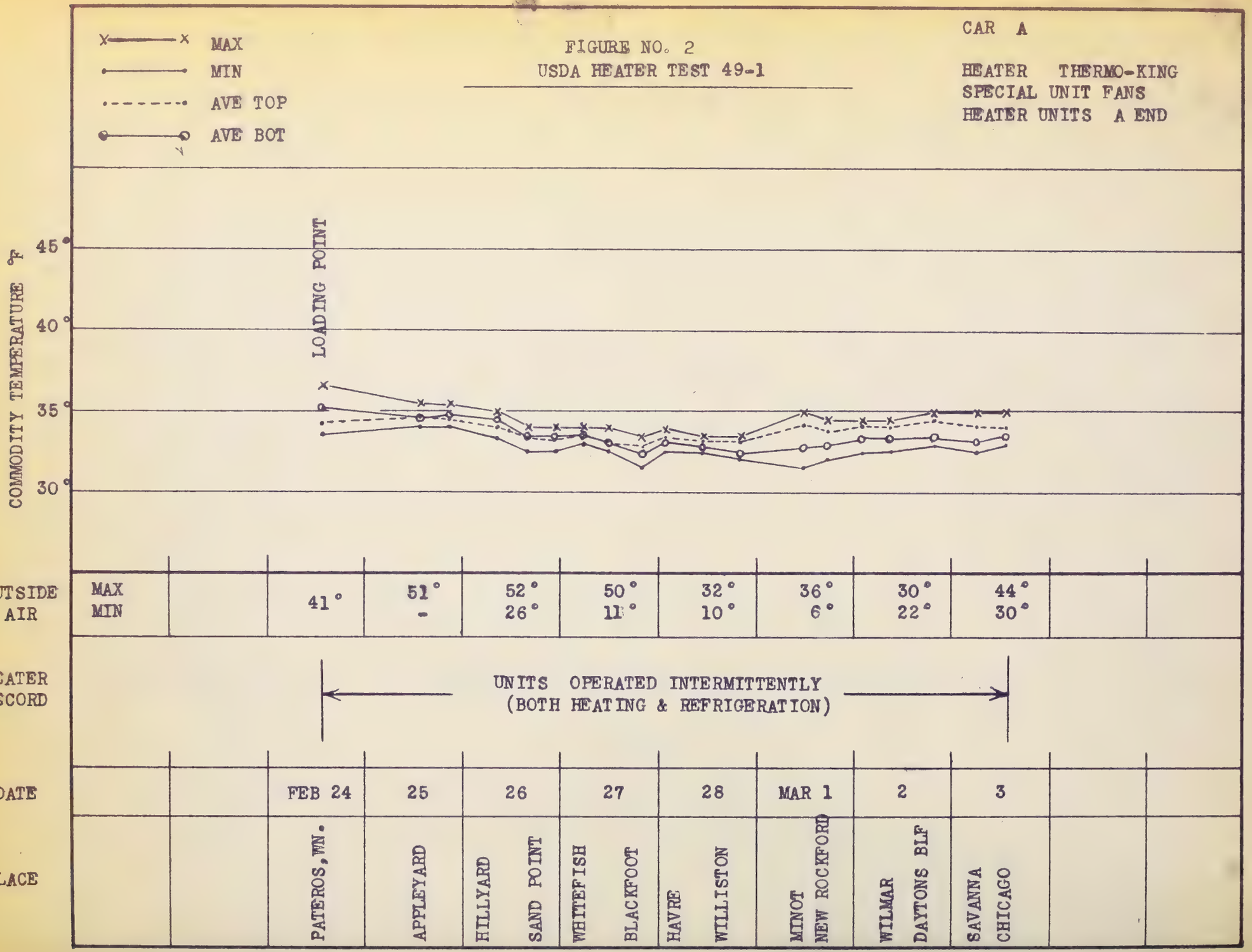


FIGURE NO. 2
USDA HEATER TEST 49-1

CAR A

HEATER THERMO-KING
SPECIAL UNIT FANS
HEATER UNITS A END

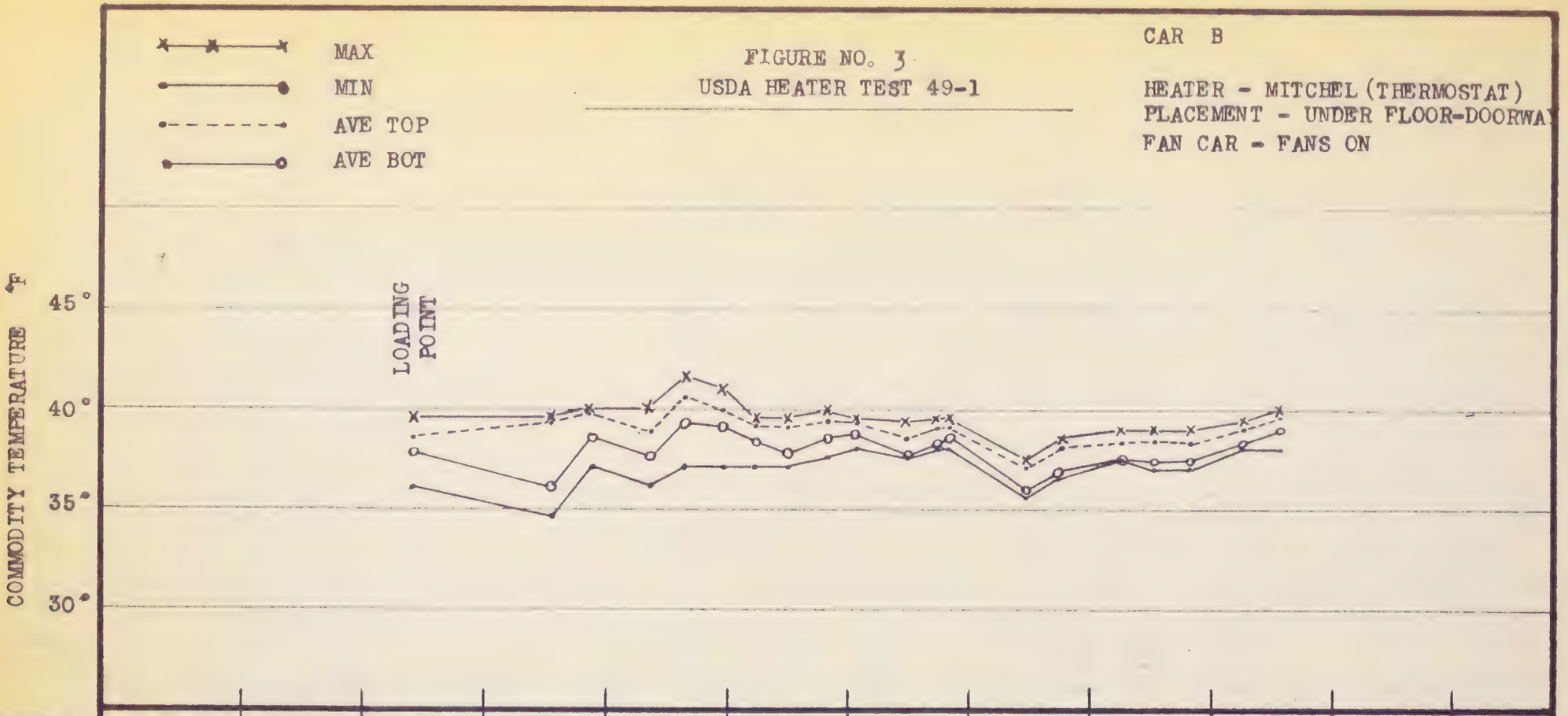


OUTSIDE AIR	MAX		41°	51°	52°	50°	32°	36°	30°	44°		
	MIN			-	26°	11°	10°	6°	22°	30°		
HEATER RECORD	UNITS OPERATED INTERMITTENTLY (BOTH HEATING & REFRIGERATION)											
DATE			FEB 24	25	26	27	28	MAR 1	2	3		
PLACE			PATEROS, WN.	APPLEYARD	HILLYARD / SAND POINT	WHITEFISH / BLACKFOOT	HAVRE / WILLISTON	MINOT / NEW ROCKFORD	WILMAR / DAYTONS BLF	SAVANNA / CHICAGO		

FIGURE NO. 3
USDA HEATER TEST 49-1

CAR B

HEATER - MITCHEL (THERMOSTAT)
PLACEMENT - UNDER FLOOR-DOORWA
FAN CAR - FANS ON

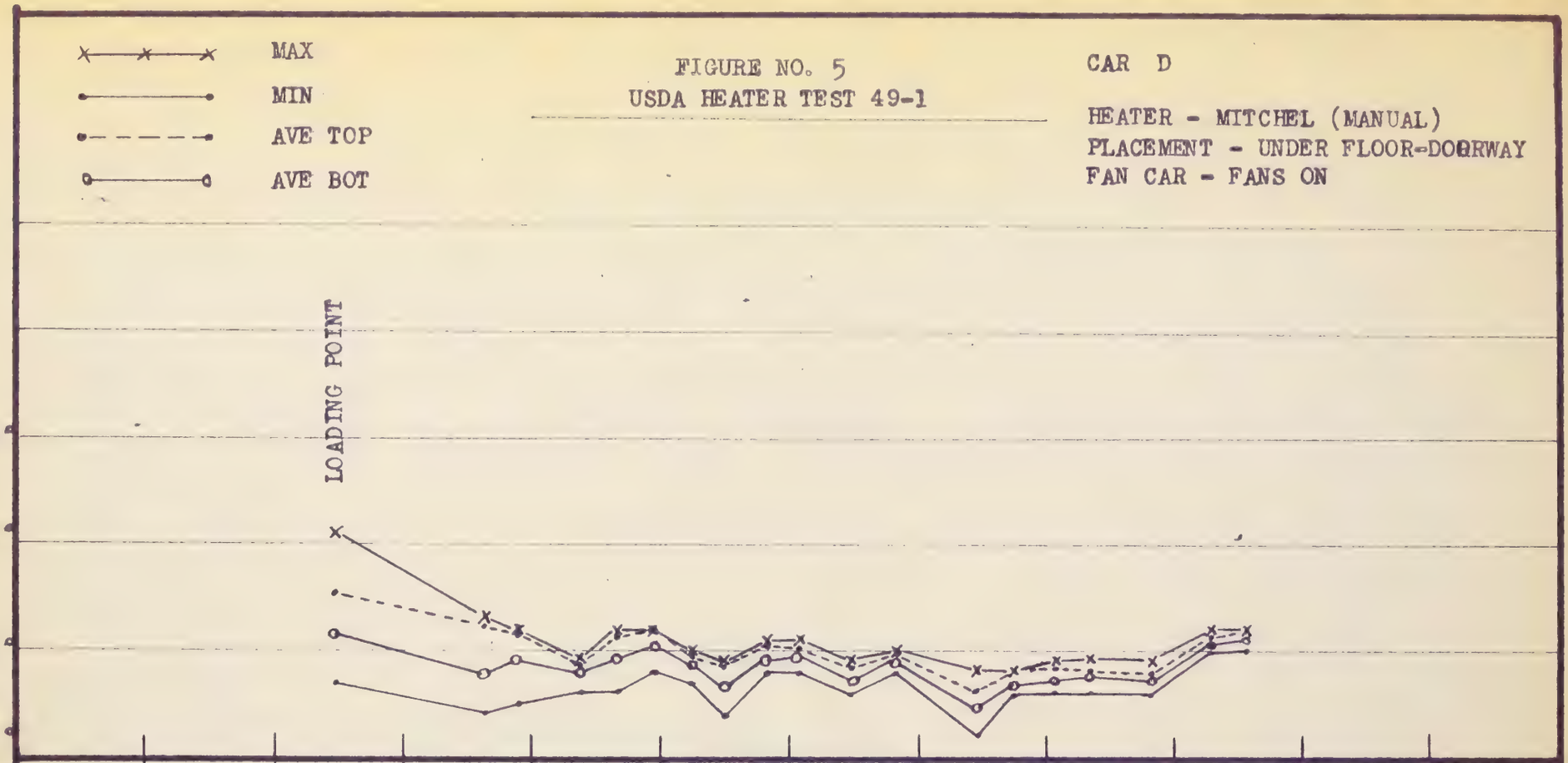


OUTSIDE AIR	MAX MIN		39°	51° -	52° 26°	50° 11°	32° 10°	36° 8°	30° 22°	44° 30°		
HEATER RECORD	FAN OPERATION											
	HEATER NOT LIT											
DATE			FEB 24	25	26	27	28	MAR 1	2	3		
PLACE			WENATCHEE	APPLEYARD	HILLYARD SAND POINT	WHITEFISH BLACKFOOT	HAVRE WILLISTON	MINOT NEW ROCKFORD	WILLMAR DAYTONS BLF	SAVANNA CHICAGO		

FIGURE NO. 5
USDA HEATER TEST 49-1

CAR D

HEATER - MITCHEL (MANUAL)
PLACEMENT - UNDER FLOOR-DOORWAY
FAN CAR - FANS ON



OUTSIDE AIR MAX		40°	51°	52°	50°	32°	36°	30°	44°			
OUTSIDE AIR MIN			-	26°	11°	10°	6°	22°	30°			
HEATER RECORD			FAN OPERATION									
			HEATER NOT LIT									
DATE		FEB 24	25	26	27	28	MAR 1	2	3			
PLACE		CASHMERE	APPLEYARD	HILLYARD SAND POINT	WHITEFISH BLACKFOOT	HAVRE WILLISTON	MINOT NEW ROCKFORD	WILLMAR DAYTONS BLF	SAVANNA CHICAGO			

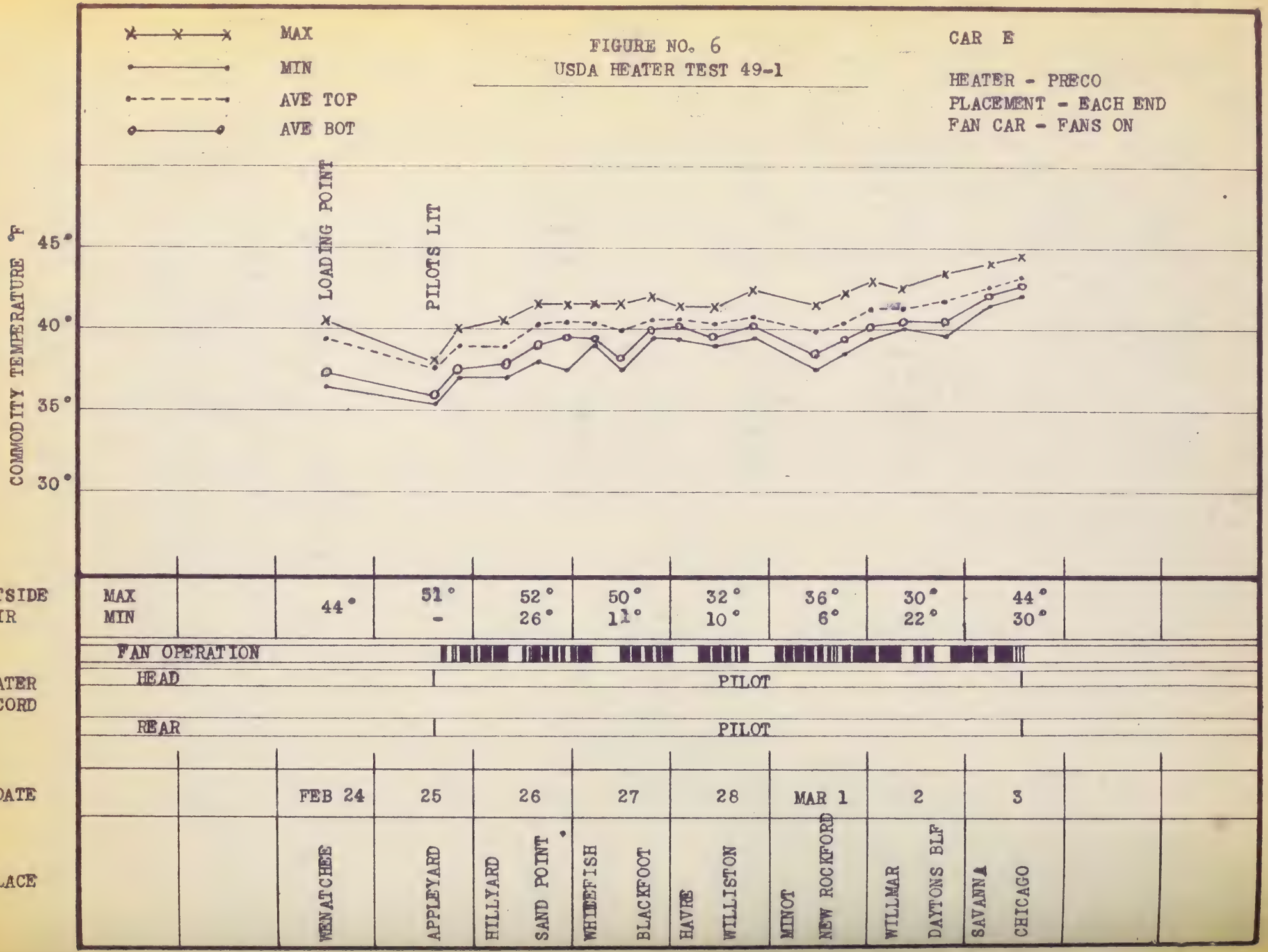
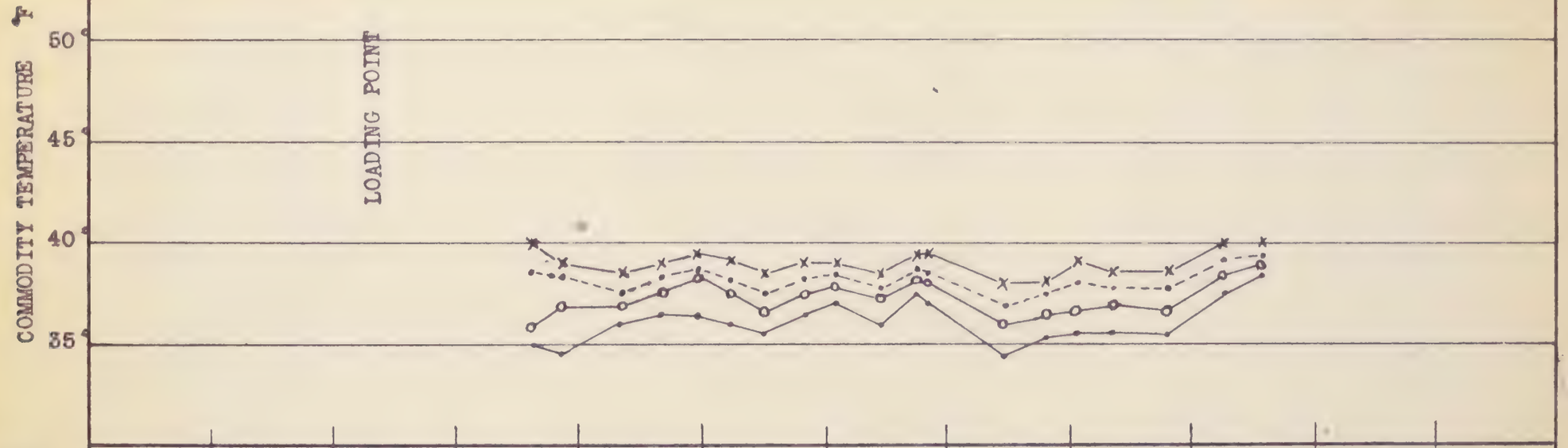

MAX
MIN
AVE TOP
AVE BOT
FIGURE NO. 6
USDA HEATER TEST 49-1
CAR E
HEATER - PRECO
PLACEMENT - EACH END
FAN CAR - FANS ON
COMMODITY TEMPERATURE °F
45°
40°
35°
30°
LOADING POINT
PILOTS LIT
OUTSIDE AIR
MAX
MIN
44° 51° 52° 50° 32° 36° 30° 44°
- 26° 11° 10° 6° 22° 30°
FAN OPERATION
HEATER RECORD
HEAD
PILOT
REAR
PILOT
DATE
FEB 24 25 26 27 28 MAR 1 2 3
PLACE
WENATCHEE
APPLEYARD
HILLYARD
SAND POINT
WHITEFISH
BLACKFOOT
HAVRE
WILLISTON
MINOT
NEW ROCKFORD
WILLMAR
DAYTONS BLF
SAVANNA
CHICAGO

FIGURE NO. 7
USDA HEATER TEST 49-1

CAR F

MAX
MIN
AVE TOP
AVE BOT

HEATER - SIMPLEX THERMOSTAT
PLACEMENT - EACH END
FAN CAR - FANS ON



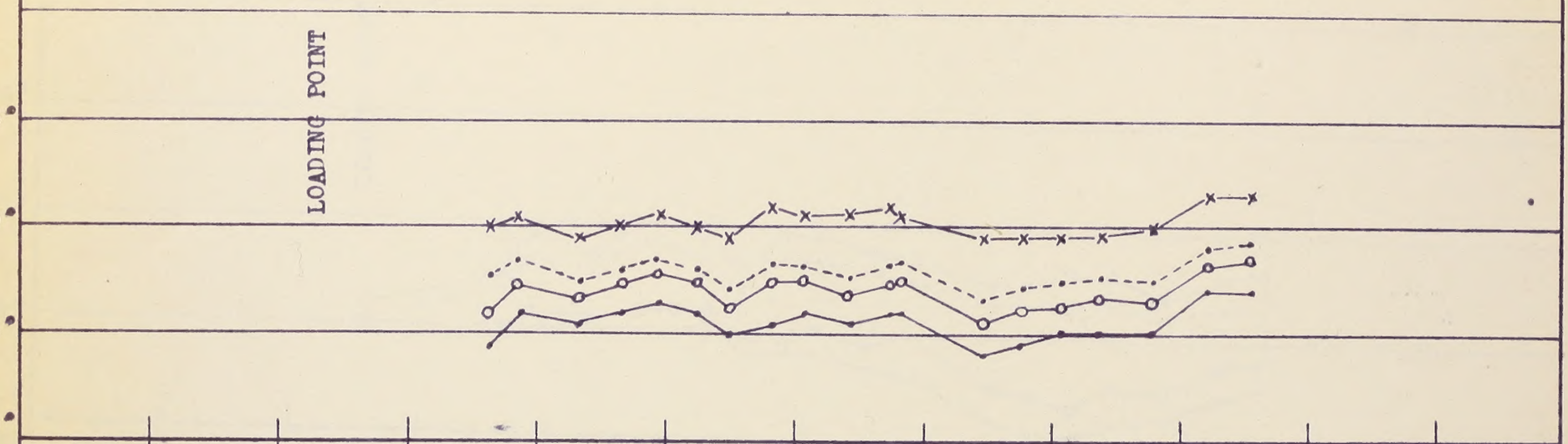
OUTSIDE AIR MAX		38°	51°	52°	50°	32°	36°	30°	44°		
OUTSIDE AIR MIN			-	26°	11°	10°	6°	22°	30°		
FAN OPERATION												
HEATER RECORD			HEATER NOT LIT									
DATE		FEB 24	25	26	27	28	MAR 1	2	3		
PLACE		CHELAN, WN	APPLEYARD	HILLYARD / SAND POINT	WHITEFISH / BLACKFOOT	HAVRE / WILLISTON	MINOT / NEW ROCKFORD	WILLMAR / DAYTONS BLF	SAVANNA / CHICAGO		

FIGURE NO. 8
USDA HEATER TEST 49-1

CAR G

MAX
MIN
AVE TOP
AVE BOT

HEATER - SIMPLEX STANDARD
PLACEMENT - EACH END
FAN CAR - FANS ON



OUTSIDE AIR MAX		36°	51°	52°	50°	32°	36°	30°	44°		
OUTSIDE AIR MIN			-	26°	11°	10°	6°	22°	30°			
FAN OPERATION												
HEATER RECORD		HEATERS NOT LIT										
DATE		FEB 24	25	26	27	28	MAR 1	2	3		
PLACE		CHELAN, WN	APPLEYARD	HILLYARD / SAND POINT	WHITEFISH / BLACKFOOT	HAVRE / WILLISTON	MINOT / NEW ROCKFORD	WILLMAR / DAYTONS BLF	SAVANNA / CHICAGO		

FIGURE NO. 9

USDA HEATER TEST 49-1

CAR H

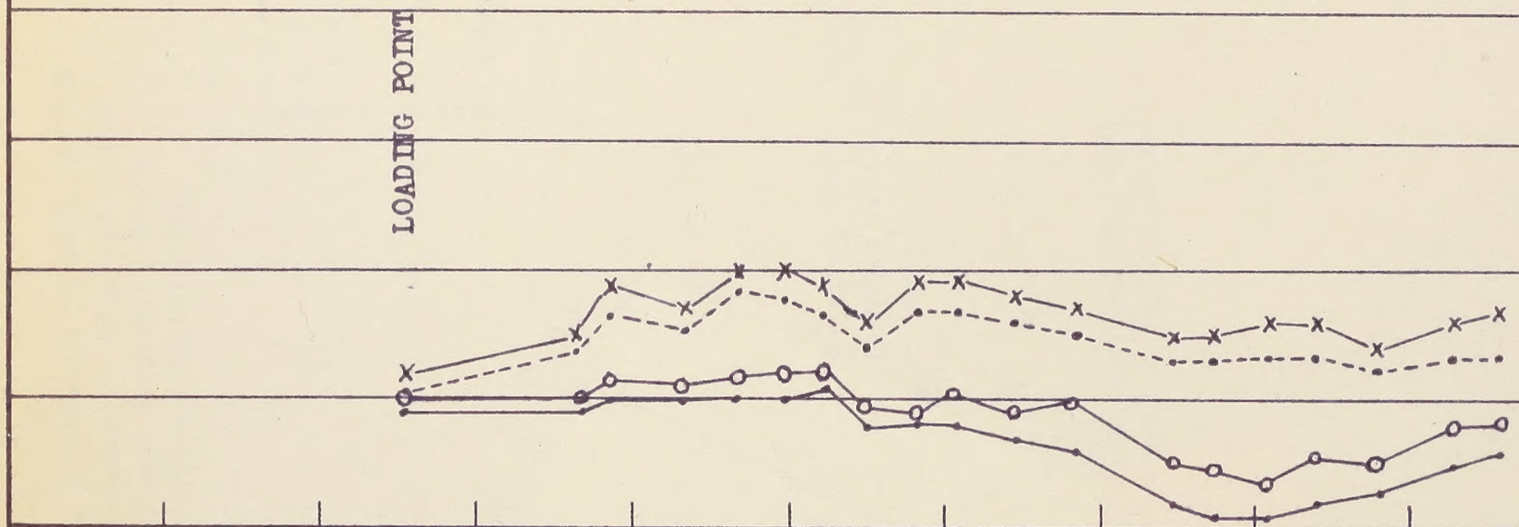
MAX

MIN

AVE TOP

AVE BOT

HEATER - SIMPLEX STANDARD
PLACEMENT - EACH END
STANDARD NON-FAN CAR



OUTSIDE AIR MAX		41°	51°	52°	50°	32°	36°	30°	44°			
OUTSIDE AIR MIN			-	26°	17°	10°	6°	22°	30°			
HEATER RECORD			HEATERS NOT LIT									
DATE		FEB 24	25	26	27	28	MAR 1	2	3			
PLACE		BREWSTER, WN	APPLEYARD	HILLYARD / SAND POINT	WHITEFISH / BLACKFOOT	HAVRE / WILLISTON	MINOT / NEW ROCKFORD	WILLMAR / DAYTONS BLF	SAVANNA / CHICAGO			